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# Cleaning Eggs for Market

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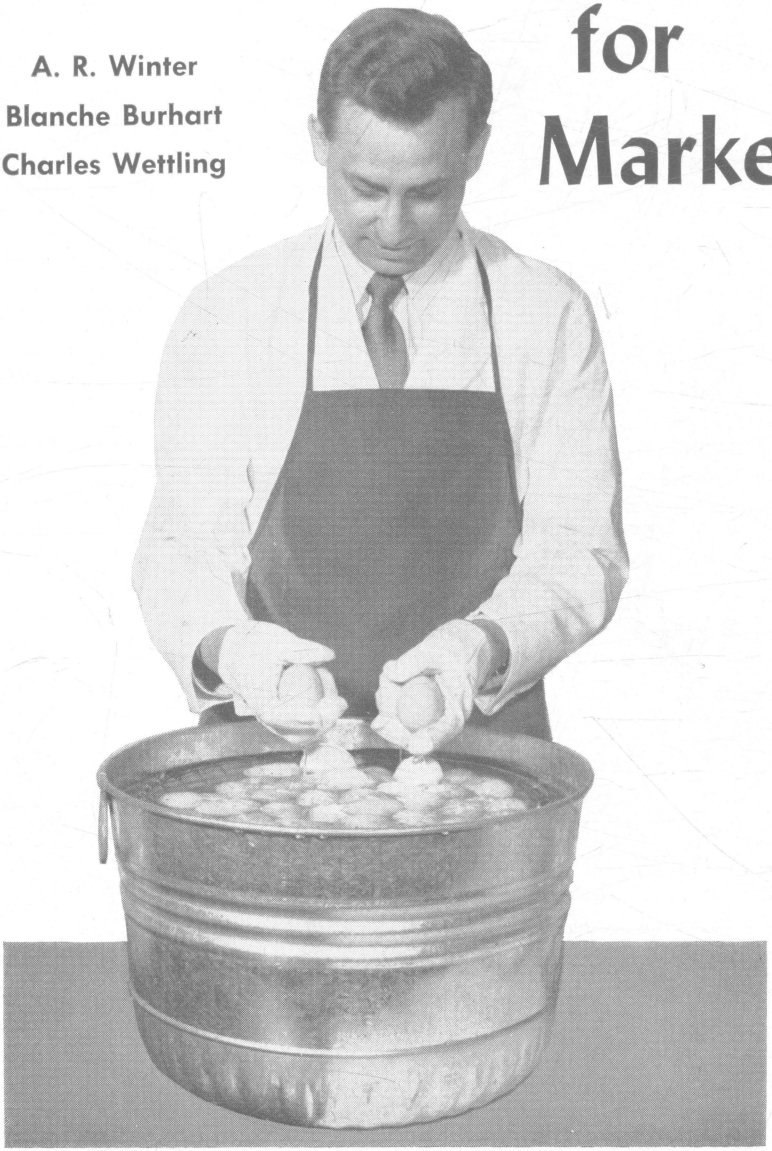

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# CONTENTS


| | |
|---|---|
| Introduction | 3 |
| Review of the Literature | 4 |
| Objectives | 6 |
| Experimental Procedures | 7 |
| Eggs | 7 |
| Candling Grade and Score | 8 |
| Holding Conditions | 8 |
| Broken Out Examination | 12 |
| Albumen Score | 12 |
| Data | 12 |
| Clean, Soiled and Cleaned Eggs | 12 |
| Unrefrigerated, refrigerated and cold storage eggs | 13 |
| Spring, Summer, Fall and Winter Eggs | 15 |
| Dry Versus Wet Cleaned Eggs | 17 |
| A Comparison of Wet Cleaning Methods | 22 |
| Washing Clean Versus Soiled Eggs | 24 |
| Rinsing Versus No Rinsing of Washed Eggs | 24 |
| Washing in Cold Versus Warm Cleaning Solution | 25 |
| Discussion | 26 |
| Summary | 27 |
| References | 29 |

# Cleaning Eggs for Market*

A. R. WINTER, BLANCHE BURHART, CHARLES WETTLING

## INTRODUCTION

Estimates and data by Huttar (1928) and Funk (1937) (1938) (1940) indicate that 10 to 25 percent of the eggs produced are soiled at the time of gathering on the farm.

Van Wagenen (1930) and Funk (1937) (1950) have shown that at least one darkened nest for every four or five layers, clean chick bed or shavings for nesting material, frequent gathering of eggs, confinement of layers and maintenance of dry houses are management practices which help to produce a higher percentage of clean eggs.

If all of the recommended practices for producing clean eggs were followed, there would still be about 10 percent soiled eggs among those gathered, according to Funk (1940). A survey by the North Central Poultry Marketing Research Committee (1949) revealed that more than 10 percent of the eggs reaching egg buying stations, in the North Central states were soiled. The percent of the eggs that had been cleaned on the farm before delivery was not known.

Each year more eggs are being sold on a graded basis. Soiled eggs, even though they may be of AA or A interior quality are generally sold as C grade, and at 10 to 15 cents less per dozen than received for the highest grades. This is stimulating more egg cleaning on the farm.

The most generally recommended practice for cleaning eggs on the farm has been to dry clean (Fig. 1) the slightly soiled eggs and to wash (Fig. 2) only the badly soiled eggs. Some large producers now wash all of the eggs gathered. According to Black (1948) and Pino (1950) the eggs are washed in the wire egg baskets in which they were gathered. The baskets of eggs are immersed repeatedly in a hot (140°-160° F.) detergent solution and then hosed with water of the same temperature. The procedure is said to save time and reduce breakage over that of sorting out the soiled eggs and washing them separately.

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**Fig. 1A.—This is one of the four dry cleaning methods used. A buffer brush covered with emery cloth was held in one hand and stain or dirt was brushed off the egg held in the other hand.**

Some egg marketing organizations as indicated by Stains (1949) of an East coast egg marketing cooperative and Casperson (1950) and Thompson (1951) of West coast organizations are opposed to all eggs or even the soiled ones being washed on the farm. They believe that the increasing number of complaints by consumers about the occurrence of sour and even black rot eggs, among those that have been candled for high quality, may be caused by washing.

## REVIEW OF THE LITERATURE

A number of investigators, Jenkins et al. (1920), Ericksen (1923), Smith (1937), Funk (1938) (1948) (1948a) (1950), Winter (1942), Gunderson (1946), Johns and Berard (1946), Solowey et al. (1946), The Council of Scientific and Industrial Research (1947), Lorentz (1948) (1949) (1950) (1950a), Kahlenberg (1950), Davidson et al. (1950), Gillespie et al. (1950), and Dawson and Davidson (1951), have reported that cleaned eggs do not keep as well as corresponding clean or soiled control eggs.

On the other hand, a number of investigators, Bryant and Sharp (1934), Wright (1948), Black (1948), Lambert (1949), Rhodes (1949), Pino (1950), Williams and Goble (1950), and Miller et al. (1950) have reported little or no harm from cleaning eggs.

A careful study of the conflicting reports reveals that many different procedures and quality measurements were used. They may explain the differences in results obtained.

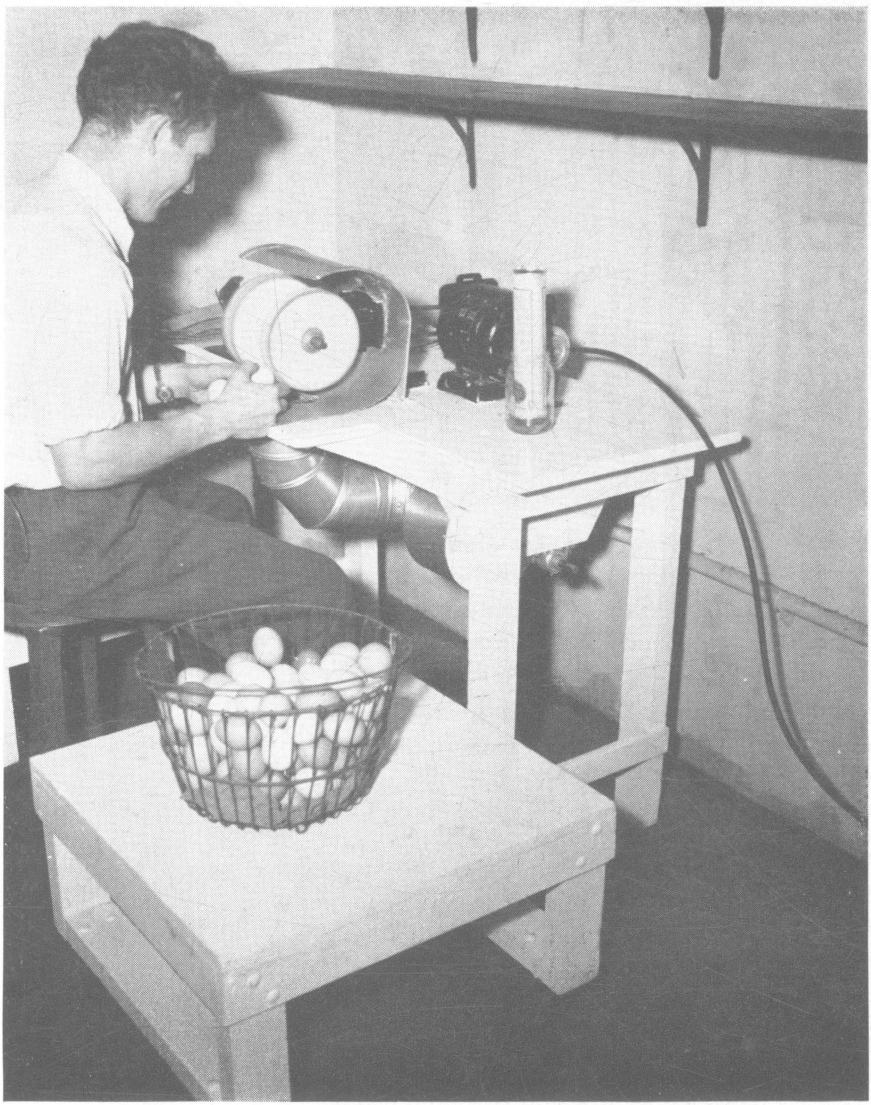


**Fig. 1B.—The egg was held against the cloth disc coated with an abrasive. A motor turned the disc.**

**Fig. 1C.—In this dry method, a motor rotated a circular emery cloth and the egg was held against the inner circle to rub off the dirt.**

## OBJECTIVES

During the last few years a number of new egg cleaning methods, cleaning machines, detergents and germicides have appeared on the market. Poultrymen, egg cleaning equipment, detergent and germicide manufacturers, egg buyers, and distributors, egg breaking plant operators, public health officials, and consumers have been interested in the efficiency, keeping quality, cost, safety, and functional properties of eggs cleaned by present day methods.

This study was made to obtain data to aid in answering the questions most frequently asked regarding cleaning of eggs.

The objectives of this phase of the study have been to obtain data on the keeping quality of eggs when:

1. Clean, soiled and cleaned.
2. Cleaned and held under summer (unrefrigerated), refrigerated and cold storage conditions.
3. Produced and cleaned during different seasons of the year.
4. Cleaned by dry and wet methods.
5. Cleaned by different wet methods.
6. Clean and soiled eggs were washed.
7. Rinsed and not rinsed.
8. Washed in cold and warm solutions.

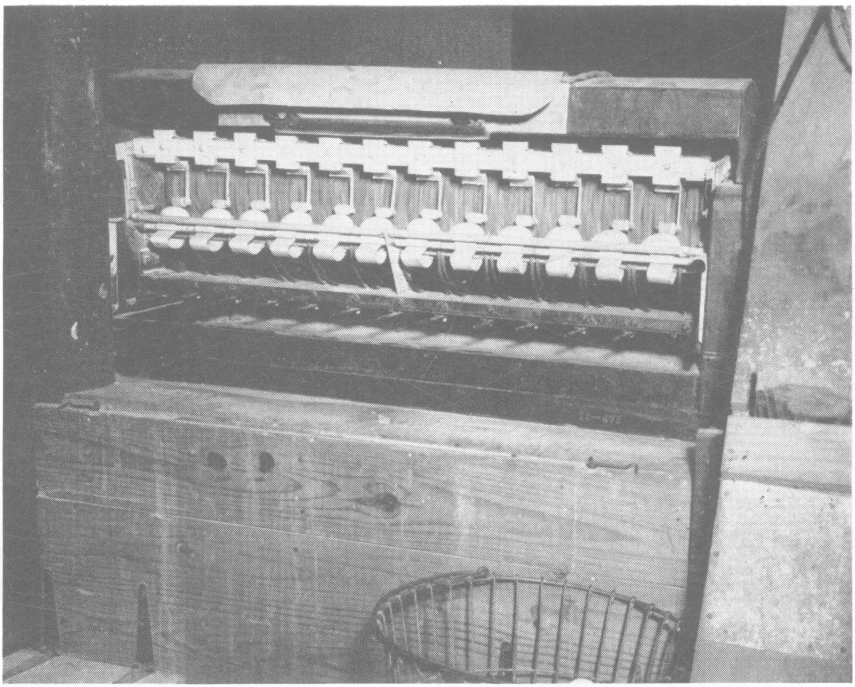


**Fig. 1D.—In this cleaning operation, both the eggs and the abrasive rotated. The cleaning took place as the eggs came in contact with the moving bands of emery cloth.**

## EXPERIMENTAL PROCEDURES

**Eggs.**—Clean, soiled and cleaned eggs were used in the tests.

Clean eggs were those which showed no visible signs of stain or dirt. They were obtained from the university poultry farm and from a commercial farm. Soiled eggs of unknown past history, except that they were more than a week old, were obtained from a local egg buying and grading station. The soiled eggs consisted of both brown and white eggs.

Artificially soiled eggs were prepared from the source of clean eggs listed above, by moistening and dipping them in a soft mixture of chicken manure, soil, litter, and fine material from the nests. The eggs were held horizontally between the thumb and first finger. About one half of the moist shell surface from end to end was pressed in the mixture. The eggs were then placed on egg case flats with the soiled surface on top and allowed to dry over night at room temperature.

Cleaned eggs, unless otherwise stated, were soiled eggs from the sources stated above which were cleaned by one of the methods referred

to later on in this report. The soiled eggs were divided at random into as many groups as were to be studied in each trial, including one group to be used as an uncleaned or soiled control.

**Candling grade and score.**—The eggs were placed in one dozen retail cartons and labeled according to kind and treatment. They were then candled and graded according to United States standards and techniques. Any egg with a cracked shell or poor shell texture or below B grade was replaced by another egg which had received similar treatment. Each egg was given a number and its candling score (grade) recorded. Eggs of AA and A quality were all considered as A grade and given a score of 3. B grade eggs were given a value of 2. Nearly all of the eggs were A grade at the beginning of the holding periods. At the end of the holding periods, the eggs were again candled, nearly always by the same person, and the same system of scoring followed, namely grade A eggs were given a score of 3, grade B a score of 2, grade C a score of 1, and inedible eggs (rots) a score of 0.

**Holding conditions.**—Similar lots of clean, soiled and cleaned eggs were held under three different conditions representing ordinary handling of eggs in the regular channels of trade: (1) Without refrigeration, (2) Handling under refrigeration, and (3) Cold storage.

**Fig. 2A.—This is one of the wet cleaning methods. Eggs were placed in a container of water or other solution, soaked as long as 30 minutes and the dirt was rubbed off with a cloth.**

**Fig. 2B.—Eggs here were immersed in a hot detergent solution and then hosed off with hot water.**

**Fig. 2C.—A spray of hot water was directed on the eggs as they passed through the machine in contact with a bristle brush and into a drying chamber.**

Eggs were held at 80° F. and 66 percent relative humidity for three weeks to represent summer handling without refrigeration. North Central states egg receivers and distributors estimated that it is probably about three weeks from the time most eggs are produced on the farm until they are received and used by the consumers in the cities.

Eggs were held at 55° F. and 82 percent relative humidity for three weeks to represent recommended practices of handling eggs under refrigeration in egg rooms, trucks, display cases and in household refrigerators.

The eggs held at 80° F. and 55° F. were removed at the end of each week, held over night at room temperature and returned the following day. This was done to represent, in a way, the removal of eggs from the farm to the grading station, from the grading station to the wholesale house or retail store and from the retail store to the consumer.

Eggs were held in a refrigerator at 35° F. and 91 percent relative humidity for five months to represent the cold storage holding of eggs. At the end of the storage period, they were removed to a room at 55° F.

**Fig. 2D.—A pump in the bottom of the can used in this method directed a spray of warm detergent against the eggs and caused them to rotate. Washing time was about two minutes.**

for a week and then to a basement room temperature, overnight, before final candling and broken out examination. The eggs held at 80° F. and 55° F. were also held overnight in the same room before final candling and broken out examination.

**Broken out examination.**—As soon as the eggs were candled at the end of the holding periods, each one that had not shown evidence of rot was broken out into the lid of a 30 pound frozen egg can. It was observed for fluorescence and other properties under a fluorescent light (100 watt E h-4 low pressure mercury vapor lamp with filter for removing most of the visible light.) Yolks which did not come loose during the candling process and which showed evidence of having stuck to the inner shell membrane when broken out, were classed as stuck yolks, unless there was some evidence of rot.

Eggs were classed as rots if they had an abnormal odor, fluoresced under the fluorescent light, showed evidence of mold or if the white or yolk appeared abnormal except as might result from the effects of heat or drying out.

**Albumen score.**—The broken out eggs were compared with a photograph of the Van Wagenen (1934) and Sharp (1934) albumen scores for eggs. To make the candling and albumen scores comparable, albumen scores for the best eggs, 1.0-2.0 were given a value of three, 2.5-3.5 a value of two and 4.0-5.0 a value of one. Albumen scores were only obtainable at the end of the trials, when the eggs were broken out.

## DATA

**Clean, soiled and clean eggs.**—Data were obtained on the keeping quality of about 24,000 eggs cleaned by various methods and on about 3,000 clean and soiled eggs used as controls (Table 1). The data covers many trials, methods of cleaning and during all seasons of the year. The average spoilage among clean eggs was 3.5 percent, soiled eggs 7.5 percent and cleaned eggs 12.6 percent (Fig. 3). The losses are a little higher than might be expected under good holding conditions. However, it should be remembered that the data included about an equal number of eggs held at 80° F. for three weeks, 55° F. for three weeks and 35° F. for five months. The holding conditions were not the most desirable. They were planned to magnify possible differences due to cleaning. Jenkins et al. (1920) reported 1.9 percent spoilage among clean eggs, 6.8 percent among soiled eggs and 14.4 percent among washed eggs.

Small numbers of eggs (usually a dozen) per treatment were used in each trial. However, more than 70 trials were conducted during the year. In some trials and under certain holding conditions, egg

TABLE 1.—Spoilage of Clean, Soiled and Cleaned Eggs

| Treatment of eggs | No. of eggs | Rots | Investigators |
|---|---|---|---|
| | | Percent | |
| Clean | 3,125 | 3.5 | Winter et al. This report |
| Soiled | 3,202 | 7.5 | |
| Cleaned | 24,454 | 12.6 | |
| Clean | | 1.9 | Jenkins et al. (1920) |
| Soiled | | 6.6 | |
| Cleaned | as high as | 14.4 | |
| Soiled | 240 | 0.8 | Council for Scientific and Industrial Research (1947) |
| Machine Cleaned | 240 | 21.2 | |
| Hand Cleaned | 240 | 3.7 | |
| Clean | Many trials—Range | 0.0- 2.5 | Funk (1948) |
| Soiled | Many trials—Range | 1.1-36.4 | |
| Cleaned | Many trials—Range | 0.3-67.3 | |
| Clean | From 28 ranches—Range | 0.0- 1.1 | Lorentz (1950) |
| Washed | From 28 ranches—Range | 0.0-38.0 | |
| Clean | 1,713 | 0.9 (sour) | Dawson et al. (1950) |
| Washed | 1,492 | 4.3 (sour) | |

spoilage of cleaned eggs was absent or negligible, while in a few instances spoilage was as high as 83 percent. This was probably due to the presence of different species and numbers of microorganisms on and in different lots of eggs.

Data found in those tests are in agreement with that of nearly all investigators who have cleaned large numbers of eggs in several different trials (Table 1). The fact that Bryant and Sharp (1934), Funk (1938), Lambert (1949), Rhodes (1949), Williams and Goble (1950) and Miller et al. (1950) reported that washing eggs did not impair their keeping quality may have been due to the small numbers of eggs used, the few trials conducted, the amount and the kind of dirt present on the eggs and the holding conditions.

**Unrefrigerated, refrigerated and cold storage eggs.**—Data were obtained on more than 19,000 eggs cleaned by various methods and on smaller numbers of clean and soiled control eggs. Approximately equal numbers of eggs were held at 80° F. for three weeks, 55° F. for three weeks and 35° F. for five months. The eggs were observed for spoilage, stuck yolks, decline in candling grade and albumen score. The data have been summarized in Table 2.

Spoilage of cleaned eggs was greatest at 80° F. and a holding period of three weeks, followed by 35° F. for five months and then 55° F. for three weeks. Eriksen (1923) observed greater spoilage among cleaned eggs as the holding temperature was increased. Jenkins et al. (1920), Gunderson (1946), Lorenz and Starr (1949) and Davidson et al. (1950) reported an increase in spoilage, especially sour eggs, as the storage time was increased.

Candling grade and albumen scores decreased as the holding temperature was increased (Table 2 and Fig. 4). The loss was slightly greater in the soiled eggs than in the cleaned ones and greater in both instances than in the clean eggs.

It was impossible to detect 36 to 65 percent of the spoiled eggs by candling alone (Table 3). More spoiled eggs were missed by candling in the soiled and cleaned eggs than in the clean control eggs. Sour and musty eggs as well as some white and green rots were not detected until the eggs were broken out. Jenkins and Bengtson (1918), Funk (1938) and others (Table 3) have reported similar observations. Lorenz


**Fig. 3.—Losses resulting from soiled and cleaned eggs.**

**TABLE 2.—Spoilage of Clean, Soiled and Cleaned Eggs Held Under Different Storage Conditions**

| Kind of eggs and holding conditions | | Number of eggs | Rots | Stuck yolks | Grade loss | Albumen score | References |
|---|---|---|---|---|---|---|---|
| | | | Percent | Percent | Percent | Average | |
| Cleaned, | 80° F. 3 wks. | 7,094 | 15.8 | 5.9 | 58.7 | 1.0 | |
| | 55° F. 3 wks. | 6,619 | 5.2 | 0.5 | 24.9 | 1.9 | |
| | 35° F. 5 mo. | 5,910 | 15.1 | 2.0 | 15.8 | 2.0 | |
| Soiled, | 80° F. 3 wks. | 1,056 | 8.0 | 4.3 | 58.5 | 1.0 | Winter et al. This report |
| | 55° F. 3 wks. | 920 | 3.1 | 1.0 | 25.7 | 1.8 | |
| | 35° F. 5 mo. | 866 | 11.2 | 2.0 | 17.7 | 2.1 | |
| Clean, | 80° F. 3 wks. | 883 | 0.9 | 1.7 | 49.2 | 2.5 | |
| | 55° F. 3 wks. | 862 | 0.5 | 0.1 | 23.5 | 2.1 | |
| | 35° F. 5 mo. | 818 | 5.1 | 1.2 | 10.6 | 2.5 | |
| Cleaned, stored | 2.5 mo. | | 0.5 | | | | |
| | 6.5 mo. | | 10.5 | | | | |
| | 11.0 mo. | | 14.4 | | | | |
| Soiled, stored | 2.5 mo. | | 0.5 | | | | Jenkins, et al. (1920) |
| | 6.5 mo. | | 3.5 | | | | |
| | 11.0 mo. | | 6.6 | | | | |
| Clean, stored | 2.5 mo. | | 0.5 | | | | |
| | 6.5 mo. | | 2.0 | | | | |
| | 11.0 mo. | | 2.0 | | | | |

(1949) did not observe sour eggs in cleaned storage eggs until they had been in storage at least 35 days. Davidson et al. (1950) found some sour eggs in both clean and washed eggs after they had been in storage three months.

In the early trials, the eggs that were held at 80° F. and 55° F. were candled at weekly intervals. Very few spoiled eggs or eggs with stuck yolks were detected by candling at the end of one week. A few bad eggs and stuck yolks were detected at the end of two weeks, especially among eggs held at 80° F. and 66 percent relative humidity. Most of the spoiled eggs and stuck yolks appeared during the third and final week of observation.

**Spring, summer, fall and winter eggs.** Soiled eggs were collected and cleaned during every week of the year. Similar soiled eggs were held as controls. Eggs were grouped by season of production to see if it had any influence on keeping quality. March, April and May eggs were classed as spring eggs; June, July and August eggs, summer; September, October, and November eggs, fall; and December, January, and February eggs, winter.

**TABLE 3.—Efficiency of Candling for the Detection of Spoiled Eggs**

| Kind of eggs | Number candled and broken out | Number of spoiled eggs detected by candling | Number of additional spoiled eggs detected by breaking out | Percent of spoiled eggs missed by candling | References |
|---|---|---|---|---|---|
| Cleaned | 17,971 | 981 | 1,451 | 60 | Winter et al. |
| Soiled | 2,315 | 62 | 117 | 65 | This report |
| Clean | 2,401 | 30 | 17 | 36 | |
| Good and poor quality | 128,577 | 4,288 | 1,697 | 28 | Jenkins and Bengtson (1918) |
| Cleaned | 34,069 | 1,453 | 2,753 | 66 | |
| Soiled | 3,771 | 67 | 249 | 76 | Funk (1948) |
| Clean | 5,206 | 5 | 31 | 86 | |
| Clean | 419 | 23 | 36 | 61 | Cotterill (1948) |
| Oiled | 1,120 | 38 | 94 | 71 | |
| Grade A | 1,756 | 0 | 29 | 1.6* | Davidson |
| B | 1,308 | 0 | 44 | 3.4* | et al. |
| C | 210 | 0 | 15 | 7.1* | (1950) |
| Cleaned | 5,760 | 521 | 427 | 45.0 | Egg Producers' Council and Council for Sci. and Ind. Research (1947-48) |

*Percent of spoiled eggs found among eggs recorded as good by candling.

The data obtained have been summarized in Table 4. The percent rots among the cleaned eggs was greatest among the summer eggs, followed in order by fall, spring, and winter eggs (Fig. 5). The loss was too great for the industry to tolerate during all seasons of the year. The data secured was in agreement with that of Funk (1948) to the extent that spoilage was greater in eggs produced and cleaned during the warm months than during the cold ones. Our data show much greater spoilage among eggs cleaned during the spring months than was reported by Funk (1938a) (1948a). It should be pointed out, however, that Funk's eggs were held under cold storage conditions while one-third of the eggs in our tests were held at 80° F.

The spoilage among the soiled control eggs followed the same seasonal trend as that of the cleaned eggs (Table 4). It ranged from 3.1

percent among winter eggs to 10.1 percent among summer eggs. The clean eggs kept well during all seasons of the year. The candling grade loss was the highest among the winter eggs and lowest among the summer eggs.

The percent of stuck yolks was greater in the cleaned eggs than in the controls. There was also a higher percent of stuck yolks in the summer and fall eggs than in the winter and spring eggs.

**Dry versus wet cleaned eggs.**—Four dry cleaning methods were used. (1) A buffer brush covered with emery cloth. The soiled egg was held in one hand and the stain or dirt brushed off with the other hand (Fig. 1, a). This method has been advocated and widely used

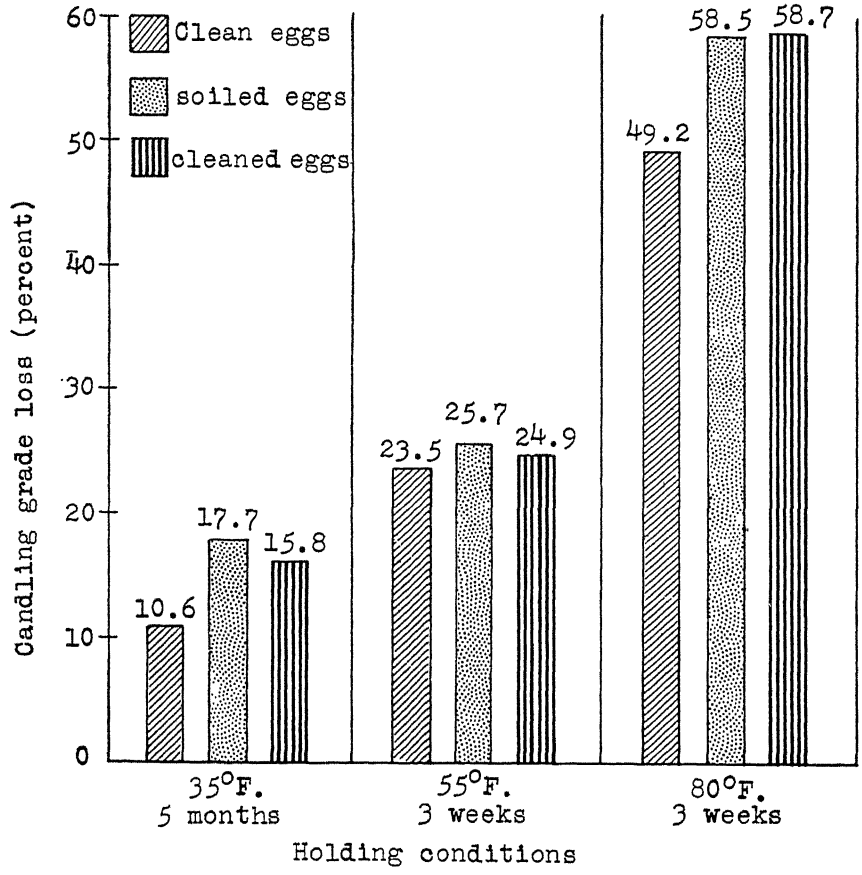



**Fig. 4.—Influence of holding conditions on the decline in candling grade of eggs.**

for cleaning light dirty (less than 20 percent of the shell surface soiled) eggs. (2) A motor rotated cloth disc coated with an abrasive. The soiled egg was held against the soft disc and the dirt removed by the abrasive (Fig. 1, b). (3) A motor rotated circular emery cloth. The egg was held against the inner circle of the emery cloth and the dirt was rubbed off (Fig. 1, c). (4) A motor operated machine for holding and moving both the eggs and the abrasive. The eggs were rotated as they came in contact with moving bands of emery cloth which pressed against them (Fig. 1, d).

Eggs were wet cleaned by four different methods. (1) Washed with a rag (Fig. 2, a). The eggs were placed in a jar, bucket, tub or garbage can of cold or warm water or other cleaning solution and after soaking from 0 to 30 minutes the dirt was rubbed off with a cloth. (2) Washed in an egg basket by immersion in a hot (140-160° F.) detergent solution and hosed off with hot water (Fig. 2, b). The eggs were immersed by raising and lowering the basket repeatedly in a can of the warm detergent solution during a 20 second period. The basket was set aside to soak while other baskets were dipped. The eggs were then re-dipped. Finally, a spray of hot (140-160° F.) water was

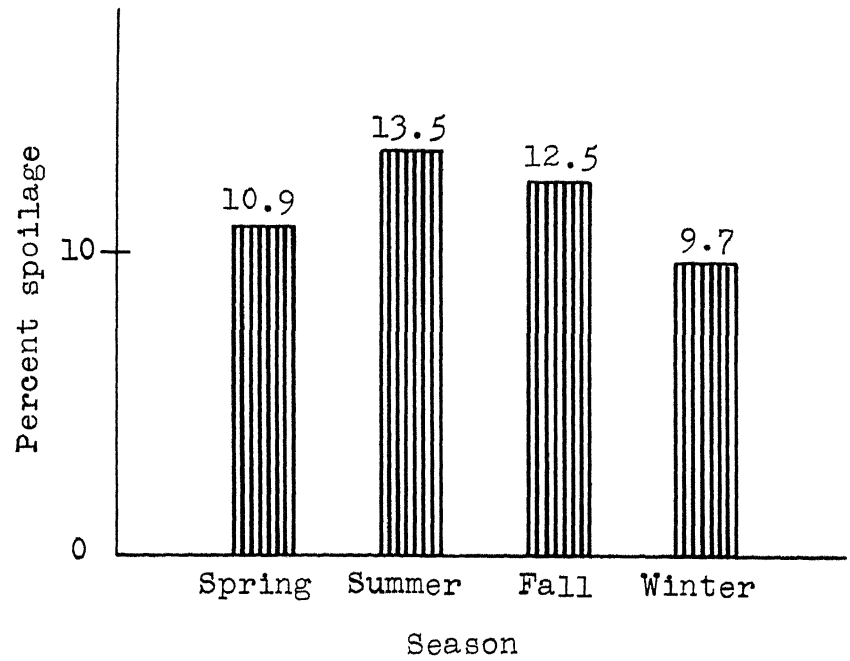



**Fig. 5.—Spoilage among eggs cleaned during different seasons of the year.**

**TABLE 4.—Influence of Season of Year on Keeping Quality of Cleaned Eggs**

| Season | Kind of eggs | Number | Rots | Stuck yolks | Grade loss | Albumen score |
|---|---|---|---|---|---|---|
| | | | Percent | Percent | Percent | Average |
| Winter | Cleaned | 3,256 | 9.7 | 3.4 | 43.2 | 1.8 |
| | Soiled | 488 | 3.1 | 1.4 | 44.1 | 1.7 |
| | Clean | 452 | 0.4 | 1.8 | 42.1 | 1.8 |
| Spring | Cleaned | 6,952 | 10.9 | 2.3 | 36.6 | 1.7 |
| | Soiled | 908 | 6.9 | 0.8 | 33.3 | 1.8 |
| | Clean | 888 | 1.3 | 0.4 | 32.9 | 1.9 |
| Summer | Cleaned | 6,139 | 13.5 | 4.0 | 27.7 | 1.7 |
| | Soiled | 804 | 10.1 | 3.8 | 30.0 | 1.7 |
| | Clean | 816 | 0.9 | 0.7 | 15.6 | 2.3 |
| Fall | Cleaned | 3,053 | 12.5 | 3.9 | 36.8 | 1.6 |
| | Soiled | 585 | 6.7 | 4.6 | 38.9 | 1.4 |
| | Clean | 348 | 1.4 | 2.3 | 27.5 | 1.8 |

directed against the eggs from a hose in order to remove the loosened dirt. (3) Washed in a machine with a spray of clean, hot water directed on the eggs (Fig. 2, c). The eggs were placed on a motor driven conveyor. They were rotated while passing through a chamber with small streams of hot water falling on them. The eggs came in contact with a rotating brush as they moved along. They passed from the washing compartment to a drying chamber where a blast of hot air was directed against them. (4) Washed in an egg basket in a can with a spray of hot detergent solution (Fig. 2, d). The basket of eggs was placed in a special can containing a warm, (120° F.) detergent solution. A spray of the detergent solution was directed against the sides and top of the basket, under pressure, from a pump located in the bottom of the can. The direction of the pressure of the solution caused the basket to rotate in the solution. The washing time was about two minutes.

The results of cleaning the eggs by the four dry cleaning methods were totaled and reported in Table 5 as dry cleaned eggs. In like manner, the results of cleaning the eggs by the four wet methods were totaled and reported as wet cleaned eggs. Results of the soiled and clean control eggs used in the trials were also totaled and shown in the same table. Spoilage in the dry cleaned eggs amounted to 12.4 percent rots and 13.9 percent in the wet cleaned eggs. Spoilage in the soiled

**TABLE 5.—Influence of Dry versus Wet Cleaning of Eggs on Keeping Quality**

| Observation | Kind of eggs | | | | References |
|---|---|---|---|---|---|
| | Dry cleaned | Wet cleaned | Soiled control | Clean control | |
| Number of eggs | 628 | 9,809 | 1,521 | 1,428 | |
| Rots, percent | 12.4 | 13.9 | 8.3 | 1.2 | |
| Stuck yolks, percent | 3.2 | 4.1 | 3.9 | 1.0 | Winter et al. |
| Grade loss, percent | 33.8 | 31.3 | 32.7 | 21.8 | This report |
| Albumen score, av. | 1.7 | 1.7 | 1.7 | 2.1 | |
| Number of eggs | 2,093 | 11,054 | 2,240 | 2,700 | Funk (1948) |
| Rots, percent | 6.3 | 4.7 | 7.2 | 1.6 | |

control eggs amounted to 8.3 percent. It was too high in all cases for the industry to bear except in the case of the clean egg controls. (Fig. 6). Cleaning, as reported earlier in this study, lowered rather

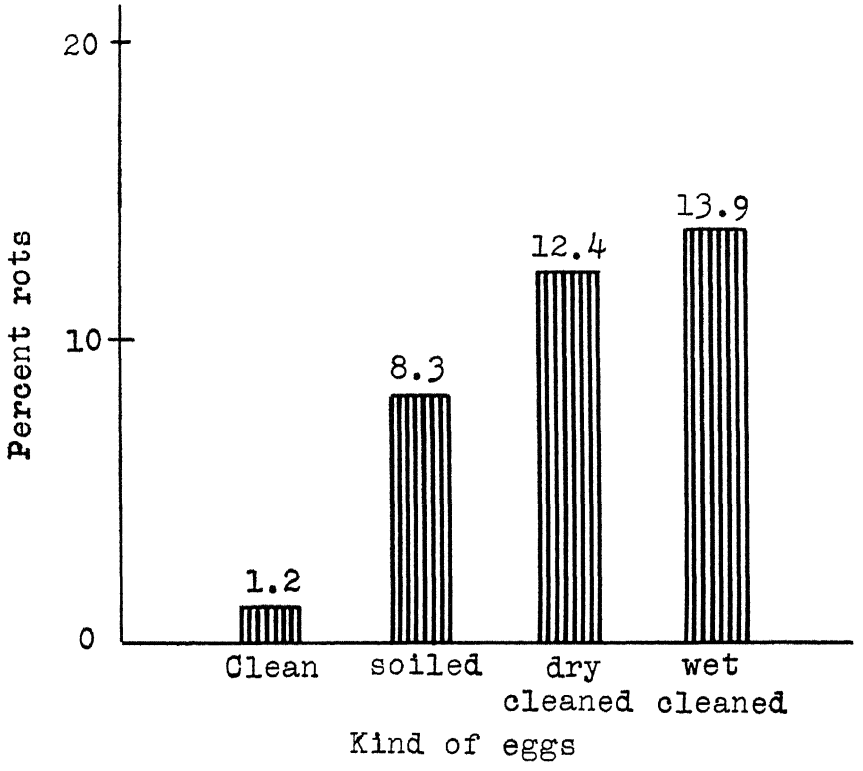



**Fig. 6.—Occurrence of rots among clean, soiled, dry cleaned and wet cleaned eggs.**

**TABLE 6.—A Comparison of Wet Cleaning Methods for the Preservation of Shell Egg Quality**

| Treatment of eggs | Number of eggs used | Rots present | Yolks stuck | Grade loss | Albumen score |
|---|---|---|---|---|---|
| | | | Percent | Percent | Percent |
| Hand washed in cold water | 2,146 | 11.4 | 2.8 | 38.6 | 1.5 |
| Machine washed in hot water | 2,034 | 17.0 | 3.2 | 40.3 | 1.5 |
| Hand washed in cold Vel solution | 1,821 | 15.3 | 3.7 | 38.1 | 1.5 |
| Cold Emulsept | 1,702 | 5.5 | 3.0 | 38.4 | 1.7 |
| Soiled eggs controls | 2,174 | 6.6 | 1.7 | 36.0 | 1.6 |
| Clean egg controls | 1,905 | 1.6 | 1.1 | 32.3 | 1.8 |

than improved the keeping quality of eggs. The keeping quality of dry cleaned eggs was not enough better than that of wet cleaned eggs to justify this method of cleaning.

No attempt was made to evaluate the four different dry cleaning methods used in cleaning badly soiled eggs since they all had the following undesirable features: (1) The abrasive removed the shell color as

**TABLE 7.—Keeping Quality of Washed Clean and Soiled Eggs**

| Kind of eggs | Number of eggs | Rots | Stuck yolks | Grade loss | Albumen score | References |
|---|---|---|---|---|---|---|
| | | Percent | Percent | Percent | Average | |
| Clean—unwashed | 648 | 0.8 | 1.1 | 17.5 | 2.3 | |
| Clean—washed | 629 | 2.7 | 0.8 | 21.3 | 2.2 | Winter et al. |
| Soiled—unwashed | 644 | 10.2 | 5.3 | 33.4 | 1.7 | This report |
| Soiled—washed | 603 | 14.4 | 3.3 | 33.1 | 1.6 | |
| Clean—unwashed | 12 | | | 24 (total) | | |
| Clean—washed | 12 | | | 17 | | |
| Soiled—unwashed | 12 | | | 22 | | Pino (1950) |
| Soiled—washed | 12 | | | 16 | | |
| Clean—unwashed | 1,440 | 0.8 | | | | Funk (1948) |
| Clean—washed | 1,419 | 1.4 | | | | |
| Clean—unwashed | 180 | 2.2 | | | | |
| Clean—washed | 180 | 11.7 | | | | Funk (1938) |
| Dirty—washed | 180 | 25.3 | | | | |

well as the dirt, in the case of brown eggs. This left the eggs with noticeable scratches and light spots or bands on them. (2) The handling and rubbing action necessary to remove stain and dirt by means of the abrasive resulted in a higher percentage of cracked and broken eggs than when wet methods were used. (3) Final traces of stain were not removed as effectively by dry methods as by wet methods of cleaning. (4) It required considerable longer time to clean by the dry methods used than by the wet ones.

The data on wet versus dry methods of cleaning of eggs are only in partial agreement with that reported by Funk (1948), (See Table 5) which shows that cleaning improved the keeping quality of soiled eggs and that wet cleaning resulted in better keeping quality than dry cleaning. His wet cleaning methods included hot water, germicides, and thermostabilization, all of which help to preserve quality of washed eggs. Funk's eggs were held in cold storage. In this study part of the eggs were held under warm conditions which resulted in greater spoilage than when held in cold storage.

The data also show a higher percentage of stuck yolks among wet cleaned eggs than among those dry cleaned. The decline in candling grade of dry and wet cleaned eggs, other than rots and stuck yolks, was about the same and also about the same as that of the soiled control eggs.

Since wet cleaning methods proved to be more satisfactory than dry methods for cleaning dirty (more than 20 percent of the shell surface soiled) eggs, further efforts were directed toward evaluating and improving them.

**A comparison of wet cleaning methods.**—Soiled eggs were divided at random into a number of lots in each of many trials. One lot was held as the soiled egg control in each trial. The following wet cleaning methods were used:

(1) **Hand cleaned with cold water.** The soiled eggs at 55° F. to 75° F., were soaked in cold tap water (50°-60° F.) for thirty minutes and the dirt and stain rubbed off with a rag. (Fig. 2, a).

(2) **Machine cleaned with hot water.** The eggs were passed through a Wright (1948) washer (Fig. 2, c). Clean, hot (160° F. or higher) water trickled down on the rotating eggs while a revolving brush rubbed against them as they passed along.

(3) **Hand washed in a cold detergent solution.** Soiled eggs were washed the same as in (1) above except one tablespoon of Vel was added per gallon of water. This is a powdered detergent. It is an ammonium salt of a sulfanated monoglyceride manufactured by Colgate Palmolive Peet Company.

(4) **Hand washed in a cold detergent-germicide solution.** Soiled eggs were washed the same as in (1) above except a tablespoon of Emulsept was added per gallon of water. This is a liquid soap like combination detergent-germicide, manufactured by the Emulsol Corporation (1944). The manufacturers recommend it for many purposes, including the cleaning of eggs. Emulsept is a 10 percent water solution of N (acyl colamino formyl methyl) Pyridinium chloride.

Part of the eggs cleaned by each method as well as the controls were held under each of the three storage conditions described under experimental procedure. The data obtained have been summarized in Table 6.

Contrary to what might be expected, there was greater spoilage among hot water machine cleaned eggs than among those cleaned by hand with cold water. Funk (1942) reported a decrease in spoilage of cleaned eggs from 24 percent when washed in water at 40° F. to 1.3 percent when washed in water at 120° F. Funk (1950) reported later that washed eggs kept satisfactorily when thermostabilized by agitation in water at 130° F. for 15 minutes. Gunderson (1946) reported 150° F. as the optimum temperature for machine washed eggs. The Council for Scientific and Industrial Research (1947) and Gillespie et al. (1950) reported greater spoilage among machine washed eggs than among those cleaned by hand. Wright (1948) reported greater spoilage of eggs washed with cold water than with water at 160° F., when washed in a machine like the one used in our tests. Pino (1950) reported good keeping quality of eggs washed by dipping in a detergent solution at 140° F. and rinsing in water of the same temperature.

The machine washed eggs did not always come out clean. Sending them through a second or even a third time did not always remove all trace of stain. However, no damage was done to the candling grade as a result of machine washing. A new model of the Wright machine has appeared on the market since our study was made.

The addition of a detergent (Vel) to the washing water facilitated the removal of dirt from the shell. However, the keeping quality of the eggs washed in the cold detergent solution was not as good as that of eggs washed in cold water. The detergent may have removed more of the cuticle from the pores of the shell and thereby facilitated the passage of more bacteria from the washing solution into the eggs.

Eggs washed in the detergent-germicide (Emulsept) solution were the only ones that kept as well or better than the soiled control eggs. The Emulsept solution appeared to be as good or better than the Vel

solution for the removal of dirt and stains. The germicide in the solution was probably responsible for the decrease in spoilage as compared with spoilage in eggs cleaned with water or Vel.

The method of cleaning did not have much effect on the percentage of stuck yolks, decline in candling grade or final albumen score. (Table 6).

**Washing clean versus soiled eggs.**—Two lots of clean eggs and two lots of soiled eggs were selected at random in each of several trials. One lot of each kind of eggs was held as the un-washed control. The others were washed by immersion in a hot detergent solution (140-160° F.) and rinsed with water of the same temperature according to the procedure described by Black (1948) and Pino (1950). A tablespoon of Vel was used per gallon of water. The solution was maintained at 160° F. The data obtained on keeping quality have been summarized in Table 7.

Washing clean eggs resulted in a small increase in the number of rots. Funk (1948) reported similar results (Table 7). Pino (1950), working with only a few eggs, found that washing did not lower the candling grade during storage at 80° F. for two weeks (Table 7). Washing soiled eggs resulted in a greater increase in the percent of rots. It is not known what the percent of rots might have been if the clean and soiled eggs had been washed together. Bryant and Sharp (1934) and Miller et al. (1950) have stated that the washing of eggs is not harmful. It is the after effect produced by bacteria that does the damage. Bacteria are always present in large numbers even on apparently clean eggs as shown by Haines (1938), Penniston and Hedrick (1947) and others. So, some bacteria will be present in solutions in which they are cleaned. The application of heat and the use of germicides in egg washing solutions will greatly reduce the number of bacteria in the washing solution and remaining on egg shells as shown by Gunderson (1946), Penniston and Hedrick (1947) and by data collected by us, which will appear in a future publication.

Washing eggs by repeated dipping and hosing, as described above, loosened the dirt and facilitated its removal. However, it did not remove all of the dirt and stain. The washing of eggs by this method did not influence the percent of stuck yolks, decline in candling grade, or the final albumen score.

**Rinsing versus no rinsing of washed eggs.**—In the early trials conducted, every other group of washed eggs was rinsed. Three or four washing compounds were used in each trial. The data covering the keeping quality of rinsed and unrinsed washed eggs and the controls have been summarized in Table 8.

**TABLE 8.—Keeping Quality of Rinsed versus Unrinsed Washed Eggs**

| Treatment | Number of eggs | Rots | Stuck yolks | Grade loss |
|---|---|---|---|---|
| | | Percent | Percent | Percent |
| Clean (control) | 1,122 | 2.8 | 0.8 | 32.8 |
| Soiled (control) | 1,135 | 5.4 | 0.7 | 34.9 |
| Washed, rinsed | 1,307 | 15.8 | 1.9 | 38.5 |
| Washed, not rinsed | 7,134 | 9.9 | 1.7 | 34.0 |

The unrinsed eggs kept considerably better than the rinsed ones. This might be expected since the presence of a detergent and especially a combination detergent-germicide would inhibit the growth of microorganisms on the shell and in the pores. In a few instances when the cleaning solution dried on the egg, the appearance of the shell was marred by the presence of a white dust. It was most noticeable on brown eggs.

If the cleaning solution is to be washed off the egg, it should be left on for a few minutes, especially when it contains a germicide, in order to permit more time for the compound to act on the microorganisms present.

**Washing in cold versus warm cleaning solution.**—Soiled eggs were divided at random into a number of different groups. One group was retained as the soiled control. The others were washed with a number of different cleaning solutions. Part of each group washed with each solution was washed in cold tap water (50°-60° F.) solutions and the others in solutions that felt slightly warm to the hand (100°-110° F.). The data obtained have been summarized in Table 9.

The percentages of spoiled eggs and the grade loss were slightly higher in eggs washed in warm solutions than when washed in cold ones.

**TABLE 9.—Keeping Quality of Soiled Eggs Washed in Warm and Cold Detergent and Detergent-Germicide Solution**

| Treatment | Number of eggs | Rots | Stuck yolks | Grade loss |
|---|---|---|---|---|
| | | Percent | Percent | Percent |
| Clean (control) | 1,122 | 2.8 | 0.8 | 32.8 |
| Soiled (control) | 1,135 | 5.4 | 0.7 | 34.9 |
| Washed (warm solution) | 2,904 | 12.4 | 1.4 | 38.1 |
| Washed (cold solution) | 5,537 | 10.8 | 3.3 | 30.5 |

The stuck yolks were a little greater among eggs washed in cold solutions. The data indicate that when all factors were considered there was no appreciable difference in the keeping quality of eggs washed in cold and warm solutions. It should be pointed out that the eggs washed in the cold solution were about the same temperature (55° F.) as the solution in which they were washed. Haines (1938), Johns and Berard (1946) and others have pointed out that eggs should not be warmer than the solution in which they are washed. Our data are not in agreement with that of Funk (1942) who reported a decrease in spoilage of eggs from 24 percent when washed in cold water (40° F.) to 1.3 percent when washed in warm water at 120° F. However, it should be pointed out that Funk's eggs were warmer than the lowest temperature of the water in which they were washed.

## DISCUSSION

This study and that of Funk (1948) and others indicate that the effect of cleaning eggs and the efficiency of cleaning methods should not be judged by tests on a few eggs or on a few trials. The kind and numbers of microorganisms present in different trials may produce markedly different results in the keeping quality of soiled and cleaned eggs.

Since spoilage was as great or a little greater among cleaned eggs held at 80° F. for three weeks than among those held at 35° F. for 5 months, one might save time and labor in conducting cold storage tests with cleaned eggs by running tests at 80° F. and predicting the results that might be expected if the eggs were held under cold storage conditions.

One may expect greater spoilage from soiled and cleaned eggs during the warm summer months, as pointed out by Funk (1948a) and as shown by our data. Bacteria multiply faster and therefore produce more damage when the weather is warm. This no doubt accounted for greater losses among cleaned eggs held at 80° F. than at 55° F. or 35° F.

Probably the reason the dry cleaned eggs did not keep much better than the wet cleaned ones was due to the use of dirty eggs which required much rubbing. The dry cleaning process probably forced bacteria through the shell surface in the same manner as they might gain entrance by the shell surface coming in contact with dirty washing solutions.

The fact that the hot water machine cleaned eggs did not keep as well as those washed in cold water may have been due to an expansion of the shell membranes, with resulting greater porosity, which would in turn facilitate the entrance of bacteria. Although the temperature of the water was hot enough (160° F. or higher) to kill most spoilage producing bacteria, it was probably not in contact with the egg shell long enough to have much killing effect. A further study of the temperature of the water for use with the machine method of cleaning would be of interest.

The poor results obtained with hot water (160° F. and above) and the satisfactory results obtained with the combination detergent-germicide (Table 6) would seem to justify a further study of the temperature of cleaning solution and the relative value of cleaning compounds. These factors are being investigated and will be reported in a future publication.

Since cleaned eggs did not keep as well as the soiled control eggs, it would appear that the longer the cleaning process was postponed the better the keeping quality that might be expected. In other words if one were marketing eggs once a week it would probably be better to lay the soiled eggs aside and wash all of them at one time, the day before marketing, rather than daily. The soiled material might be a little harder to remove if the washing were done once a week rather than daily. However, there would be a saving in time and cleaning material if it had to be prepared only once a week rather than daily. We are collecting data on the time to clean eggs and will report it in a future publication. To date, data have been collected on about 700 artificially soiled eggs washed after one day and after one week. The keeping quality of both groups has been about the same.

## SUMMARY

Clean eggs kept better than soiled eggs and soiled eggs kept better than cleaned eggs.

Clean, soiled and cleaned eggs kept the best when held at 55° F. for three weeks, followed by 35° F. for five months and 80° F. for three weeks.

Soiled eggs produced and cleaned during the winter kept the best followed in order by spring, fall and summer eggs.

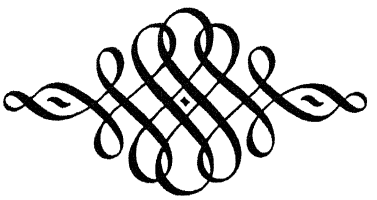
Eggs cleaned by four dry methods kept very little better than those cleaned by wet methods. Dry cleaning of dirty eggs (more than 20 percent of the shell surface soiled) was slower, less efficient and resulted in greater breakage than wet cleaning methods.

Eggs cleaned by wet methods did not keep as well as the soiled control eggs. The addition of a detergent (Vel) to the cleaning water at the level of one tablespoon per gallon facilitated the removal of dirt but did not improve the keeping quality of the cleaned eggs. The addition of a combination detergent-germicide (Emulsept) at the same level facilitated the removal of dirt and improved the keeping quality of the cleaned eggs.

Washing clean eggs resulted in a small decline in keeping quality.

Eggs washed in detergent and combination detergent-germicide solution and not rinsed kept better than eggs similarly cleaned and rinsed.

Cold eggs washed in cold (50°-60° F.) cleaning solutions kept better than those washed in similar warm (100°-110° F.) solutions.



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